WE CLAIM:

1. A micro-positioning device adapted for movement along a guideway in a direction of travel, the device having:

   a frame;

   at least one actuator, said at least one actuator being attached to the frame and adapted for activation to achieve a displacement of the device in the direction of travel; and

   at least one hydraulic booster attached to the frame and operably connected to said at least one actuator, said at least one hydraulic booster being adapted for converting mechanical energy into hydraulic energy when said at least one actuator is activated and converting said hydraulic energy into mechanical energy to modify the displacement.

2. A micro-positioning device according to claim 1 in which said at least one hydraulic booster includes a housing and a fluid in a cavity defined by the housing, the housing including at least one input portion adjacent to said at least one actuator, said at least one input portion being adapted to cooperate with the fluid to convert mechanical energy produced by said at least one actuator upon activation thereof into hydraulic energy, and the housing additionally including at least one output portion adapted to convert said hydraulic energy into mechanical energy to modify the displacement.

3. A micro-positioning device according to claim 2 in which said at least one input portion has an input contact area over which said at least one input portion is in contact with the fluid and said at least one output portion has an output contact area over which said at least one output portion is in contact with the fluid and the input contact area is greater than the output contact area, whereby the hydraulic booster is adapted to amplify the displacement.

4. A micro-positioning device according to claim 2 in which said at least one input portion has an input contact area over which said at least one input

portion is in contact with the fluid and said at least one output portion has an output contact area over which said at least one output portion is in contact with the fluid and the input contact area is less than the output contact area whereby the hydraulic booster is adapted to de-amplify the displacement.

5. A micro-positioning device adapted for movement along a guideway, the device having:

a frame having first and second opposing ends and a middle portion positioned therebetween;

at least three actuators, two of said at least three actuators being attached to the frame at the first and second ends thereof respectively, one of said at least three actuators being positioned in the middle portion of the frame, said at least three actuators being adapted for activation and de-activation in synchronism to achieve a linear displacement of the device in a direction of travel along the guideway;

at least two clamps, each of said at least two clamps being positioned respectively at the first and second ends of the frame and operably connected respectively to the actuators positioned at the opposing ends, each of said at least two clamps being adapted for clamping to the guideway upon activation of the actuator connected thereto respectively and for releasing upon de-activation thereof; and

at least one hydraulic booster attached to the frame and connected to said middle actuator, said at least one hydraulic booster being adapted for converting mechanical energy into hydraulic energy when the middle actuator is activated and converting said hydraulic energy into mechanical energy to modify the displacement.

6. A micro-positioning device according to claim 5 in which the hydraulic booster includes a fluid in a cavity defined by at least two opposing pistons and at least one wall portion, each of said pistons being connected to said at least one wall portion by at least one resilient element respectively such

that activation of the middle actuator deforms said at least one resilient element connecting said piston adjacent to said actuator.

7. A micro-positioning device according to claim 6 in which one of said at least two pistons is an input piston positioned adjacent to the middle actuator and one of said at least two pistons is an output piston positioned distal from the middle actuator and in which the area of the input piston in contact with the fluid is substantially greater than the area of the output piston in contact with the fluid, such that activation of the middle actuator causes amplification of the displacement.

8. A micro-positioning device according to claim 6 in which one of said at least two pistons is an input piston positioned adjacent to the middle actuator and one of said at least two pistons is an output piston positioned distal from the middle actuator and in which the area of the input piston in contact with the fluid is substantially less than the area of the output piston in contact with the fluid, such that activation of the middle actuator causes de-amplification of the displacement.

9. A micro-positioning device adapted for movement in a direction of travel along a guideway, the device having:

a frame having first and second opposing ends and a middle portion positioned therebetween;

at least first and second actuators attached to the frame at the first and second ends of the frame respectively, each of said first and second actuators having a clamp operably connected thereto respectively adapted for clamping to the guideway upon activation of said actuator connected thereto respectively and for releasing upon de-activation thereof;

at least one middle actuator attached to the frame in the middle portion thereof;

said at least three actuators being adapted for activation and de-activation in synchronism to achieve a displacement in the direction of travel; and

at least one hydraulic booster attached to the frame and operably connected to the middle actuator, said at least one hydraulic booster being adapted for converting mechanical energy into hydraulic energy when the middle actuator is activated and converting said hydraulic energy into mechanical energy to modify the displacement.

10. A micro-positioning device according to claim 9 in which said at least one hydraulic booster includes a housing having an inner cavity containing a fluid, the inner cavity being defined by an input piston positioned adjacent to the middle actuator and an output piston positioned distal to said at least one middle actuator and at least one wall portion, the input piston being connected to said at least one wall portion by a first resilient element and the output piston being connected to said at least one wall portion by a second resilient element, the input piston having an input piston area in contact with the fluid and the output piston having an output piston area in contact with the fluid, said input piston area being greater than said output piston area, such that activation of the middle actuator deforms the first and second resilient elements from static positions to deformed positions, storing elastic energy therein, the first and second resilient elements returning to the static positions upon release of said elastic energy.

11. A micro-positioning device according to claim 10 in which each said resilient element comprises a rubber mount.

12. In a micro-positioning device adapted for displacement along a guideway in a direction of travel, the device having a frame having first and second opposing ends and a middle portion positioned therebetween, at least first and second actuators attached to the frame at the first and second ends of the frame respectively, each of said first and second actuators having a clamp operably connected thereto respectively adapted for clamping to the guideway upon activation of said actuator connected thereto respectively and for releasing upon de-activation thereof, at least one middle actuator attached to the frame in the middle portion thereof, said at least three

actuators being adapted for activation and de-activation in synchronism to achieve a displacement in the direction of travel, the improvement in which the device includes at least one hydraulic booster attached to the frame and to said at least one middle actuator and adapted for converting mechanical energy into hydraulic energy and converting said hydraulic energy into mechanical energy upon activation of said at least one middle actuator to modify the displacement.

13. A micro-positioning device adapted for incremental movement along a guideway, the device having:

a frame;

at least one actuator coupled to the frame, said at least one actuator being activatable to an activated state, in which said at least one actuator has an activated configuration, and de-activatable to a de-activated state, in which said at least one actuator has a de-activated configuration, the activated configuration and the de-activated configuration differing substantially from each other; and

at least one clamp operable between a clamped state, in which said at least one clamp is clamped to the guideway to maintain the micro-positioning device stationary relative to the guideway, and a released state, in which the device is movable relative to the guideway;

said at least one clamp being operably coupled to said at least one actuator such that, upon activation of said at least one actuator, said at least one clamp is in the clamped state, and upon de-activation of said at least one actuator, said at least one clamp is in the released state; and

at least one hydraulic booster coupled to the frame and connected to said at least one actuator, said at least one hydraulic booster being adapted to convert a first amount of mechanical energy into hydraulic energy and to convert hydraulic energy into a second amount of mechanical energy upon activation of said at least one actuator to result in a displacement of the device along the

guideway, the first amount and the second amount of mechanical energy differing substantially from each other.

14. A micro-positioning device according to claim 13 in which said at least one hydraulic booster has:

an input portion adjacent to said at least one actuator, the input portion having an input booster contact area in contact with a booster material contained in said at least one hydraulic booster;

an output portion with an output booster contact area in contact with the booster material; and

the input booster contact area being substantially larger than the output booster contact area, such that the output amount of mechanical energy is greater than the input amount of mechanical energy.

15. A micro-positioning device according to claim 13 in which said at least one hydraulic booster has:

an input portion adjacent to said at least one actuator, the input portion having an input booster contact area in contact with a booster material contained in said at least one hydraulic booster;

an output portion with an output booster contact area in contact with the booster material; and

the input booster contact area being substantially smaller than the output booster contact area, such that the output amount of mechanical energy is less than the input amount of mechanical energy.

16. A micro-positioning device for incremental movement along a guideway, the device having:

a frame having first and second opposing ends and a middle portion positioned therebetween;

at least three actuators, two of said at least three actuators being coupled to the frame at first and second ends thereof respectively,

one of said at least three actuators being a middle actuator positioned in the middle portion;

each of said at least three actuators being activatable to an activated state, in which each said actuator has an activated configuration;

one of said actuators being a first actuator positioned at the first end of the frame and another of said actuators being a second actuator positioned at the second end of the frame;

at least two clamps, each of said at least two clamps being operable between a clamped state, in which said clamp is clamped to the guideway to maintain the micro-positioning device stationary relative to the guideway, and a released state, in which the device is movable relative to the guideway;

each of said at least two clamps being coupled to one of the first and second actuators respectively such that, upon activation of one of said actuators, each said clamp is in the clamped state, and upon de-activation of said respective actuator, each said clamp is in the released state;

said at least three actuators being adapted for activation and de-activation in synchronism to achieve a linear displacement of the device in a direction of travel along the guideway;

at least one hydraulic booster coupled to the frame and positioned between said middle actuator and said second actuator; and

said at least one hydraulic booster being adapted to convert mechanical energy resulting from the activation of the first actuator and the middle actuator in series into hydraulic energy and converting said hydraulic energy into mechanical energy to modify the displacement.

17. A micro-positioning device according to claim 16 in which the hydraulic booster includes:

a body with a cavity;

a fluid in the cavity;

an input piston coupled to said middle actuator and having a contact area in communication with the fluid, the input piston being adapted to transmit mechanical energy resulting from activation of said middle actuator to the fluid;

an output piston having a contact area in communication with the fluid, the output piston being adapted to convert fluid energy to mechanical energy;

the contact area of the input piston being substantially greater than the contact area of the output piston;

the mechanical energy resulting from the movement of the fluid against the input piston contact area being greater than the mechanical energy resulting from the activation of said middle actuator, such that displacement of the device is increased.

18. A micro-positioning device according to claim 16 in which the hydraulic booster includes:

a body with a cavity;

a fluid in the cavity;

an input piston coupled to said middle actuator and having a contact area in communication with the fluid, the input piston being adapted to transmit mechanical energy resulting from activation of said middle actuator to the fluid;

an output piston having a contact area in communication with the fluid, the output piston being adapted to convert fluid energy to mechanical energy;

the contact area of the input piston being substantially less than the contact area of the output piston;

the mechanical energy resulting from the movement of the fluid against the input piston contact area being greater than the mechanical energy resulting from the activation of said middle actuator, such that displacement of the device is decreased.

19. A micro-positioning device adapted for movement in a direction of travel along a guideway, the device having:

a frame having first and second opposing ends and a middle portion positioned therebetween;

at least first and second actuators attached to the frame at the first and second ends of the frame respectively, each of said first and second actuators having a clamp operably connected thereto respectively adapted for clamping to the guideway upon activation of said actuator connected thereto respectively and for releasing upon de-activation thereof;

at least one middle actuator attached to the frame in the middle portion thereof;

said at least three actuators being adapted for activation and de-activation in synchronism to achieve a displacement in the direction of travel; and

at least one hydraulic booster attached to the frame, said at least one hydraulic booster including:

a housing having an inner cavity;

a fluid in the inner cavity;

the housing having an input portion connected to said at least one middle actuator;

the input portion having an input contact area in communication with the fluid, the input portion being adapted to convert mechanical energy imparted from said at least one middle actuator into fluid energy in the fluid;

the housing having an output portion with an output contact area in communication with the fluid, the output portion being adapted to convert fluid energy in the fluid to mechanical energy;

the input contact area differing substantially from the output contact area,

whereby, upon activation of said at least one middle actuator, mechanical energy is imparted to the input portion and converted to fluid energy and fluid energy is converted by the output portion into mechanical energy to modify the displacement.

20. In an inchworm mechanism adapted for incremental movement along a guideway in a direction of travel, the device having a frame having first and second opposing ends and a middle portion positioned therebetween, at least first and second actuators attached to the frame at the first and second ends thereof respectively, each of said first and second actuators having a clamp coupled therewith respectively adapted for clamping to the guideway upon activation of said respective actuator connected thereto and for releasing upon de-activation thereof, at least one middle actuator attached to the frame in the middle portion thereof, said at least three actuators being adapted for activation and de-activation in synchronism to achieve a displacement in the direction of travel, the improvement in which the device includes at least one hydraulic booster attached to the frame adjacent to said at least one middle actuator and adapted for converting mechanical energy into hydraulic energy when the middle actuator is activated and converting said hydraulic energy into mechanical energy to modify the displacement.

21. A micro-positioning device adapted for displacement in at least one direction of travel, the device including:

a frame;

at least one actuator attached to the frame and adapted for activation and de-activation in sequence to effect said displacement; and

at least one hydraulic booster attached to the frame and operably connected to said at least one actuator, said at least one hydraulic booster being adapted for converting mechanical energy into hydraulic energy and converting said hydraulic energy into mechanical energy upon activation of said at least one actuator to modify the displacement.

22. A micro-positioning device according to claim 21 in which said at least one hydraulic booster includes a housing and a fluid in a cavity defined by the housing, the housing including at least one input portion adjacent to said at least one actuator, said at least one input portion being adapted to

cooperate with the fluid to convert mechanical energy produced by said at least one actuator upon activation thereof into hydraulic energy, and the housing additionally including at least one output portion adapted to convert said hydraulic energy into mechanical energy to modify the displacement.

23. A micro-positioning device according to claim 22 in which said at least one input portion has an input contact area over which said at least one input portion is in contact with the fluid and said at least one output portion has an output contact area over which said at least one output portion is in contact with the fluid and the input contact area is greater than the output contact area, whereby the hydraulic booster is adapted to amplify the displacement.

24. A micro-positioning device according to claim 22 in which said at least one input portion has an input contact area over which said at least one input portion is in contact with the fluid and said at least one output portion has an output contact area over which said at least one output portion is in contact with the fluid and the input contact area is less than the output contact area whereby the hydraulic booster is adapted to de-amplify the displacement.